Fluid Mechanics

1.1 Course Number: CH121

1.2 Contact Hours: 3-1-0 Credits:11

1.3 Semester -offered: 1st Year- even

1.4 Prerequisite: Basic concepts of Physics (Newtons law, acceleration, velocity, momentum, kinematics of particle motion) and Mathematics (vectors, calculus, matrices, vector calculus, simple ODE, basic idea of PDE)

1.5 Syllabus Committee Member: Dr. Koushik Guha Biswas & Dr. Amit Ranjan

2. **Objective:**

- To acquaint with the properties of fluids, stresses in fluids, and the applications of fluid mechanics.
- To impart skills to correlate mathematical equations with the physical phenomena.
- To acquaint with the techniques employed to formulate, understand, and solve problems pertaining to fluid-structure interactions under both hydrostatic and flow conditions.
- To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum, and energy equation in fluid flow.
- To frame and analyze problems related to calculation of forces in fluid structure interactions.
- To familiarize with the ideas of boundary layers and turbulence.

3. **Course Content**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Introduction to fluids and fluid properties	Background, Basic definitions, Fluid properties, Viscosity, Newton's law of viscosity, Types of fluid and flow, Newtonian vs Non-Newtonian**,** Deformation of fluids, Compressibility	3
2	Kinematics of Flow	Basic concepts on laminar flow and turbulent flow, Description of fluid motions, Velocity field approach (timeline, streamline, streakline & pathline), Eulerian and Lagrangian approach, Potential flow	6
3	Fluid Statics (Pressure and its measurement)	Pressure distribution, Buoyancy, Manometry, Forces on submerged surfaces	4

4	Basic equations in integral form for a control volume	Reynolds transport theorem	3
5	Conservation Equations	Mass Balance, Energy equation**,** Bernoulli equation, Momentum balance,Navier-Stokes (NS) equation and its simple applications (Poiseuille flow & Couette flow)	11
6	Dimensional Analysis	Similitude and modelling: using non-dimensionalization of N-S equations and boundary conditions. Applications. Dimensionless numbers.	5
7	Boundary Layer Theory	Boundary Layers: Flow in boundary layers, Laminar and turbulent boundary layers, Transition length, Boundary layer separation	5
8	Turbulence	Turbulence: Transition from laminar to turbulent flows, Nature of turbulence, Isotropic turbulence, Reynolds stress, Eddy viscosity	3
		Total	**40**

4. **Readings**

4.1 Text Books:

1. An Introduction to Fluid Mechanics by Fox and Mcdonald, 7th Edition, John Wiley
2. Fluid Mechanics by Frank M White, 6th Edition, McGraw-Hill
3. Fluid Mechanics: Fundamentals and Applications by Cengel & Cimbala, 4th Edition, McGraw-Hill
4. Fluid Mechanics and its applications by Vijay Gupta & Santosh K Gupta, 3rd Edition, New Age International Publishers

4.2 Reference Books:

1. Unit Operations of Chemical Engineering by Warren McCabe, Julian Smith, Peter Harriott, 7th Edition, McGraw-Hill
2. Unit operations by G.G. Brown, CBS Publisher

5. **Outcome of the Course:**

- Identify and attain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
- Recognize these principles written in form of mathematical equations.
- Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.
- To apply Bernoulli principle and calculate pressure drop in flow systems of different configurations.